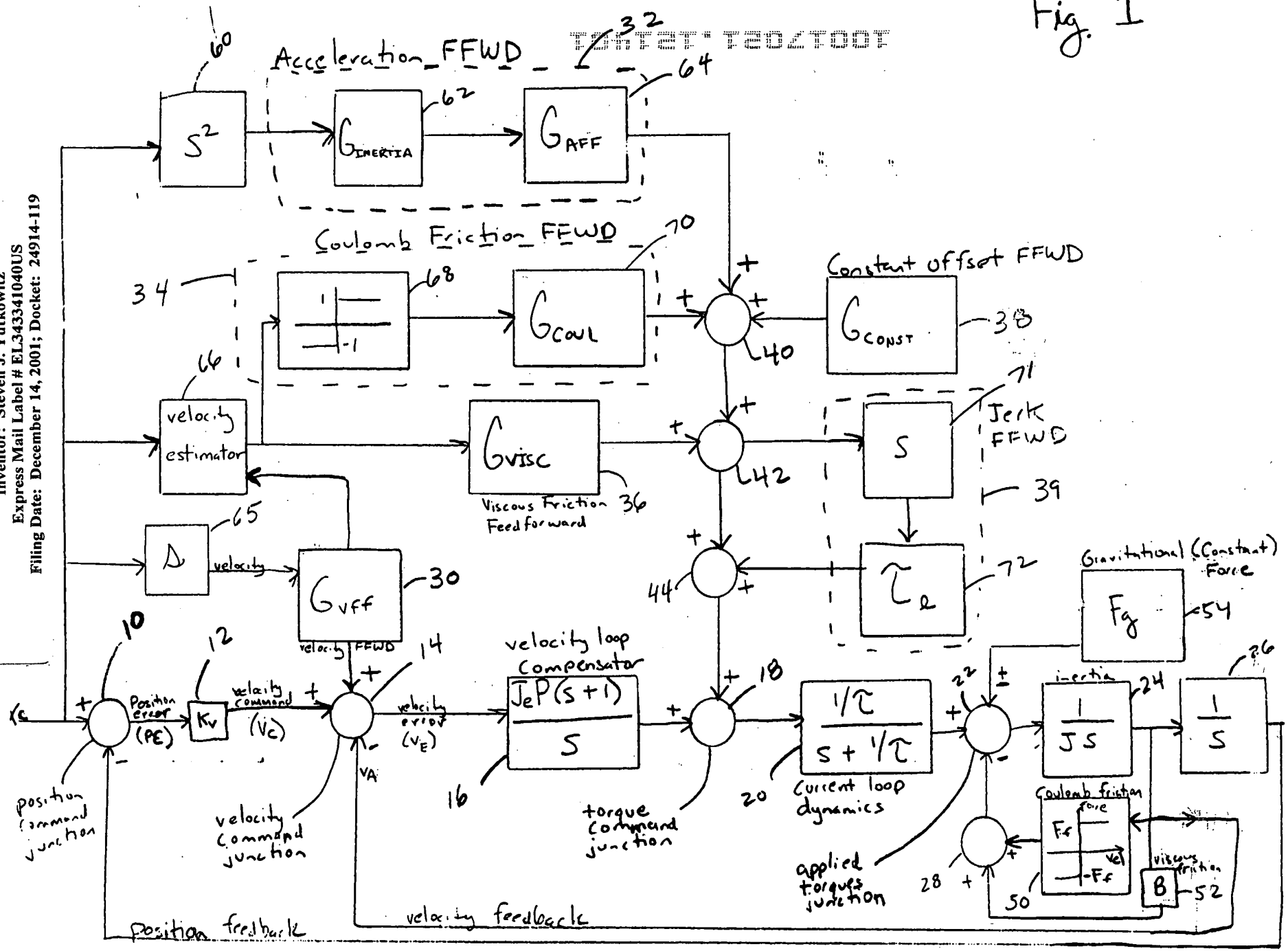
Title: Method and Apparatus for Tuning Compensation Parameters
Inventor: Steven J. Yutkowitz
Express Mail Label # EL343341040US
Filing Date: December 14, 2001; Docket: 24914-119

Fig. 1



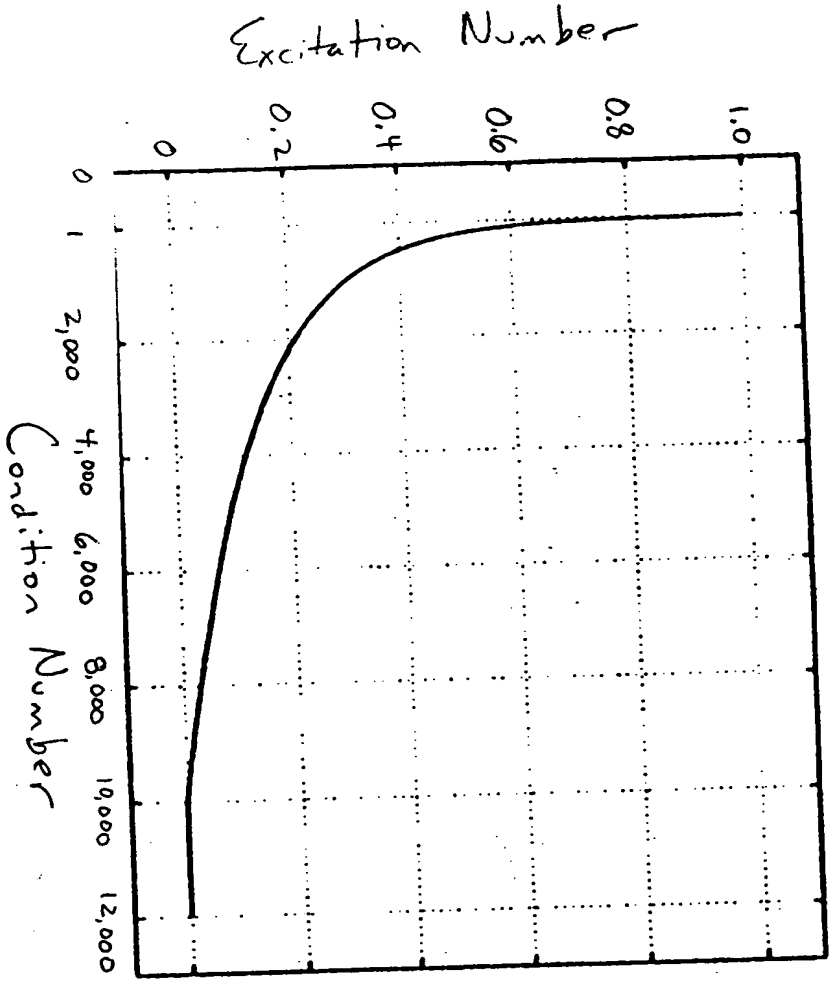

Excitation Number
0
0.2
0.4
0.6
0.8
1.0
Condition Number
0
1
2,000
4,000
6,000
8,000
10,000
12,000

Fig. 2

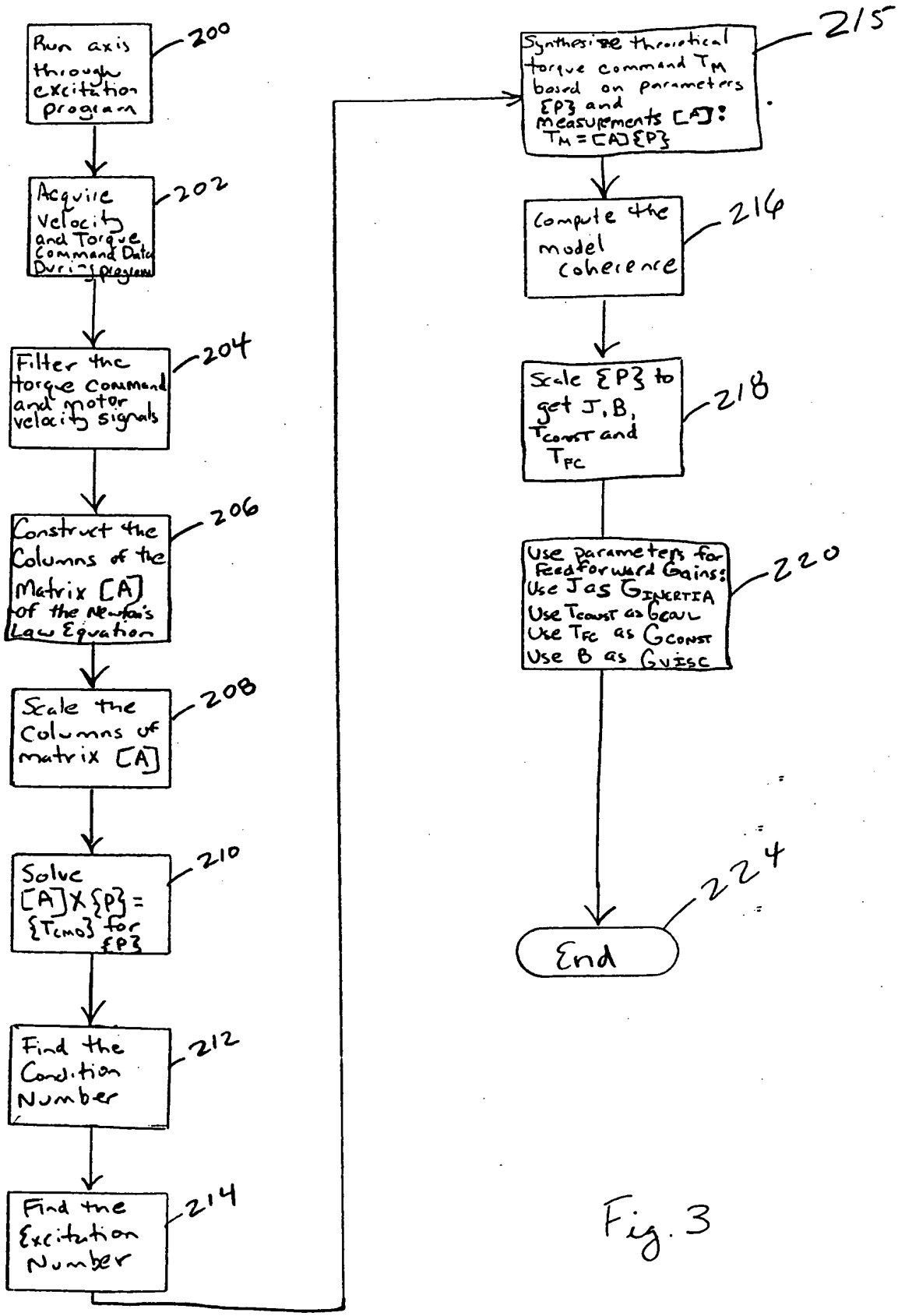

Run axis through excitation program
200
Acquire Velocity and Torque Command Data During Program
202
Filter the torque command and motor velocity signals
204
Construct the Columns of the Matrix [A] of the Newton's Law Equation
206
Scale the Columns of matrix [A]
208
Solve [A] X {P} = {T_CMD} for {P}
210
Find the Condition Number
212
Find the Excitation Number
214
Synthesize theoretical torque command T_M based on parameters {P} and measurements [A]: T_M = [A]{P}
215
Compute the model coherence
216
Scale {P} to get J, B, T_CONST and T_FC
218
Use parameters for Feedforward Gains: Use J as G_INERTIA Use T_CONST as G_CAUL Use T_FC as G_CONST Use B as G_VISC
220
End
224

Fig. 3

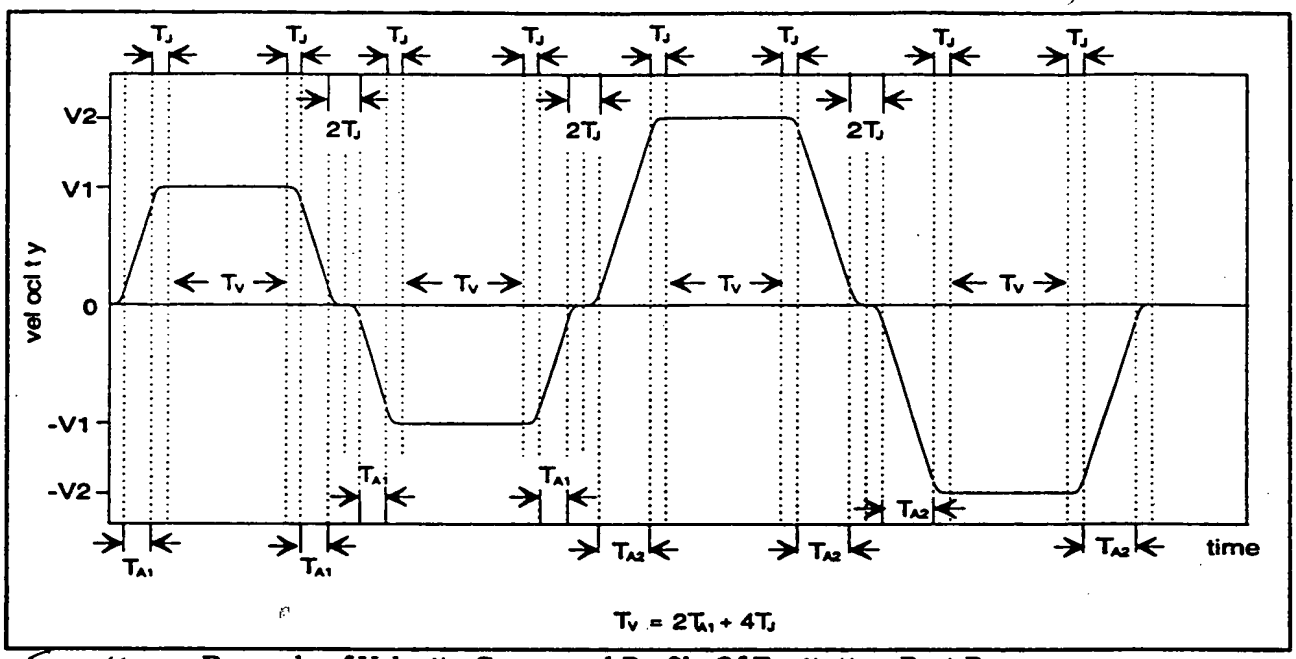


Fig. 4 - Example of Velocity Command Profile Of Excitation Part Program

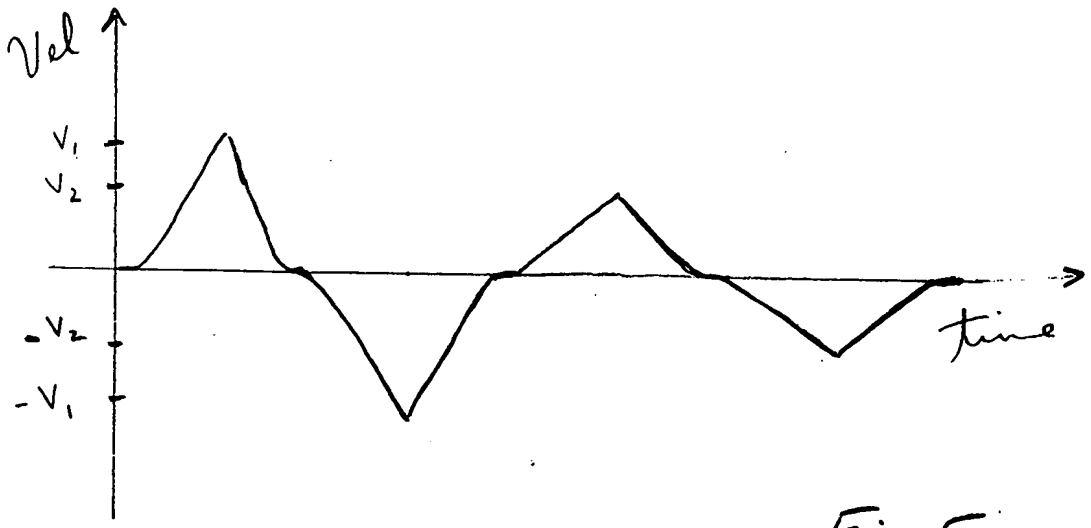


Fig. 5

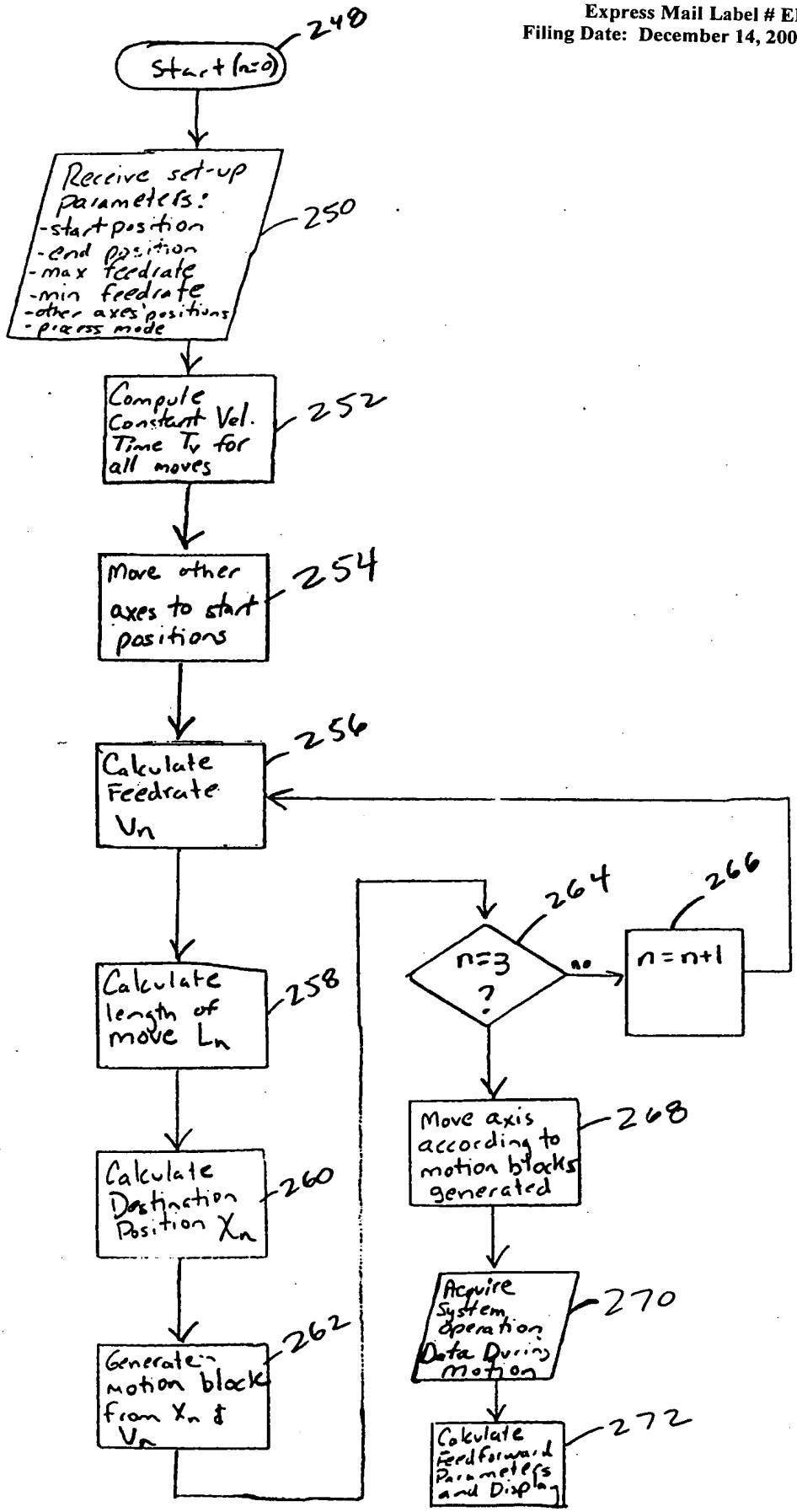

Start (n=0)
248
Receive set-up parameters:
-start position
-end position
-max feedrate
-min feedrate
-other axes' positions
-process mode
250
Compute Constant Vel. Time T_v for all moves
252
Move other axes to start positions
254
Calculate Feedrate V_n
256
Calculate length of move L_n
258
Calculate Destination Position X_n
260
Generate motion block from X_n & V_n
262
n=3 ?
264
no
n = n+1
266
Move axis according to motion blocks generated
268
Acquire System Operation Data During Motion
270
Calculate Feedforward Parameters and Display
272

FIG. 6

Title: Method and Apparatus for Tuning Compensation Parameters
Inventor: Steven J. Yutkowitz
Express Mail Label # EL343341040US
Filing Date: December 14, 2001; Docket: 24914-119

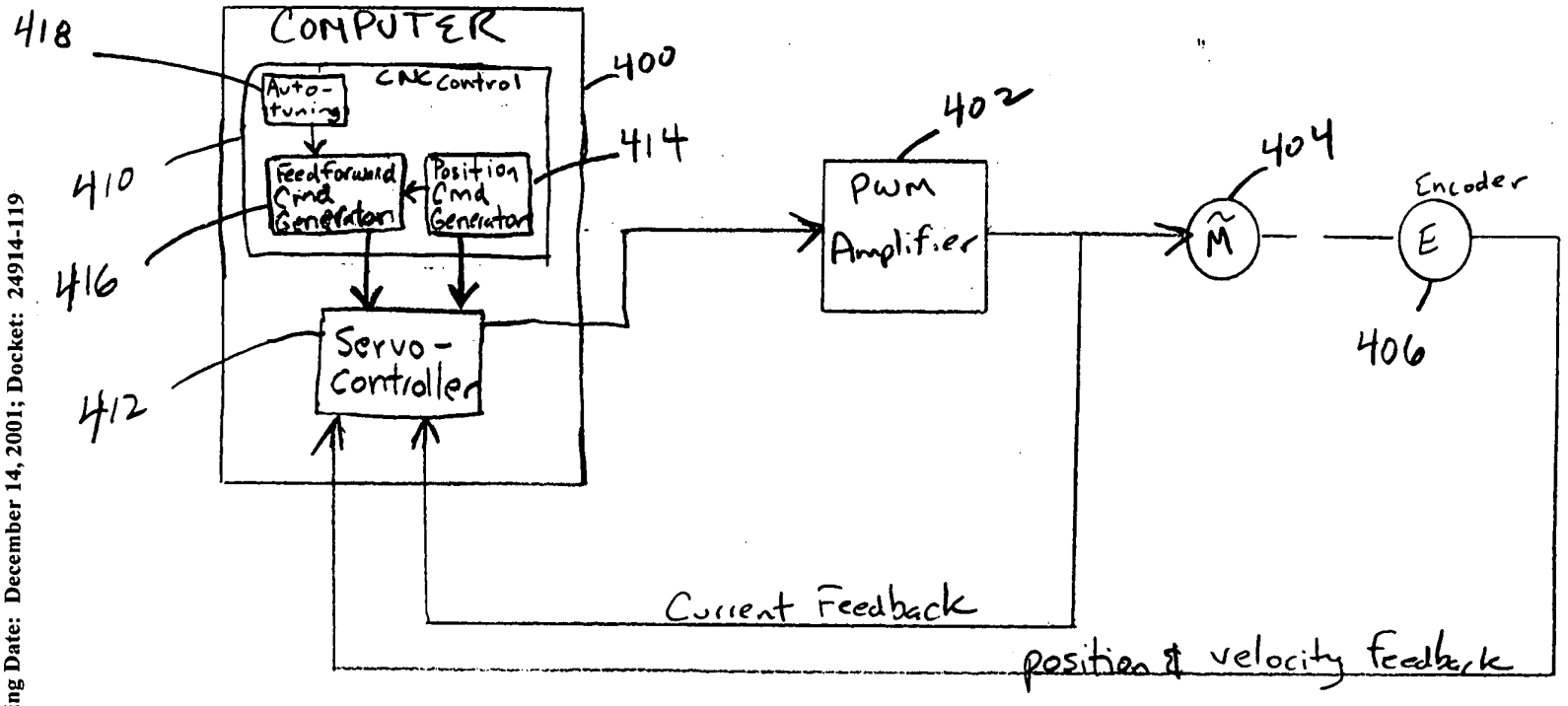


Fig. 7

Title: Method and Apparatus for Tuning Compensation Parameters
Inventor: Steven J. Yutkowitz
Express Mail Label # EL343341040US
Filing Date: December 14, 2001; Docket: 24914-119

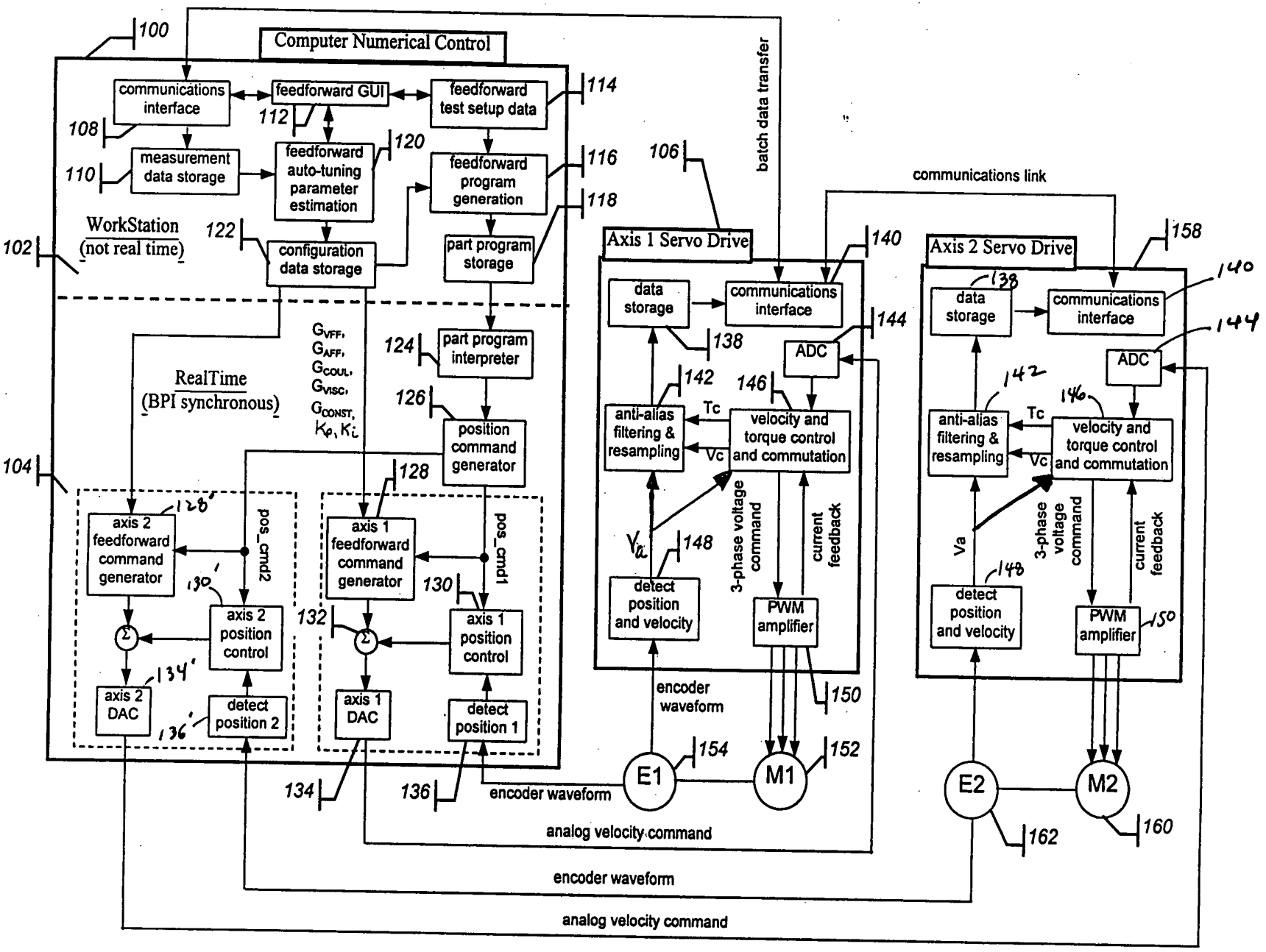


Fig. 8

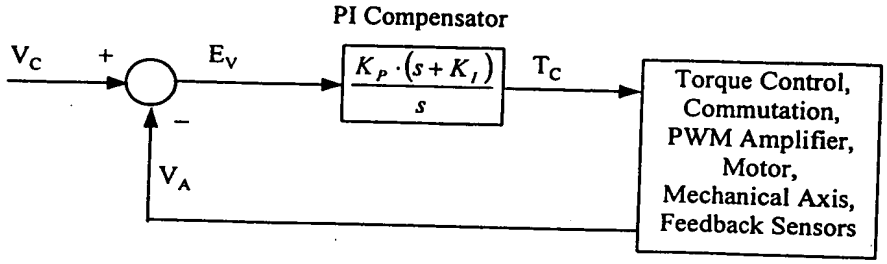

PI Compensator
V_C
+
E_V
$\frac{K_P \cdot (s + K_I)}{s}$
T_C
Torque Control, Commutation, PWM Amplifier, Motor, Mechanical Axis, Feedback Sensors
−
V_A

Fig. 9

Title: Method and Apparatus for Tuning Compensation Parameters
Inventor: Steven J. Yutkowitz
Express Mail Label # EL343341040US
Filing Date: December 14, 2001; Docket: 24914-119

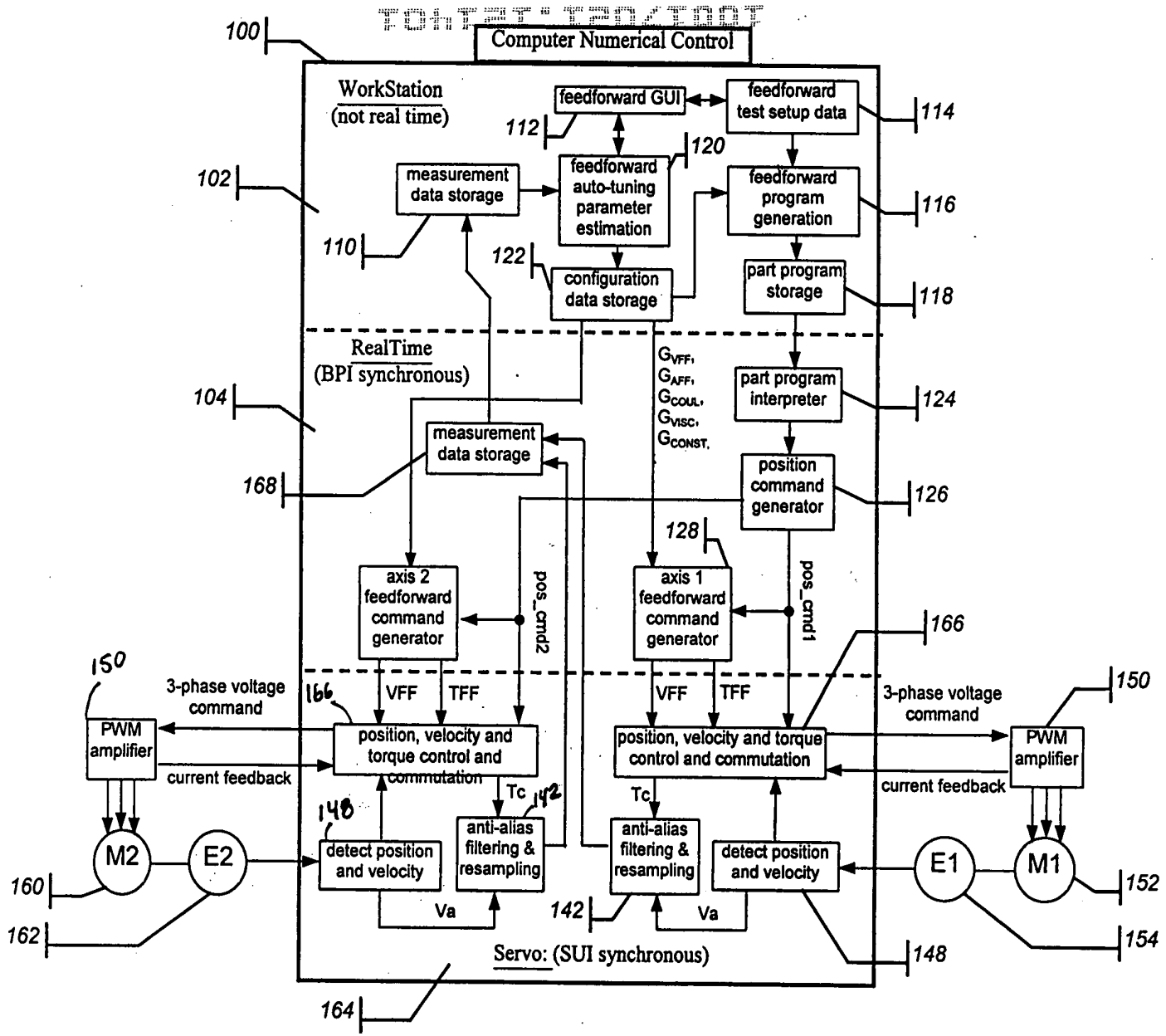


Fig. 10

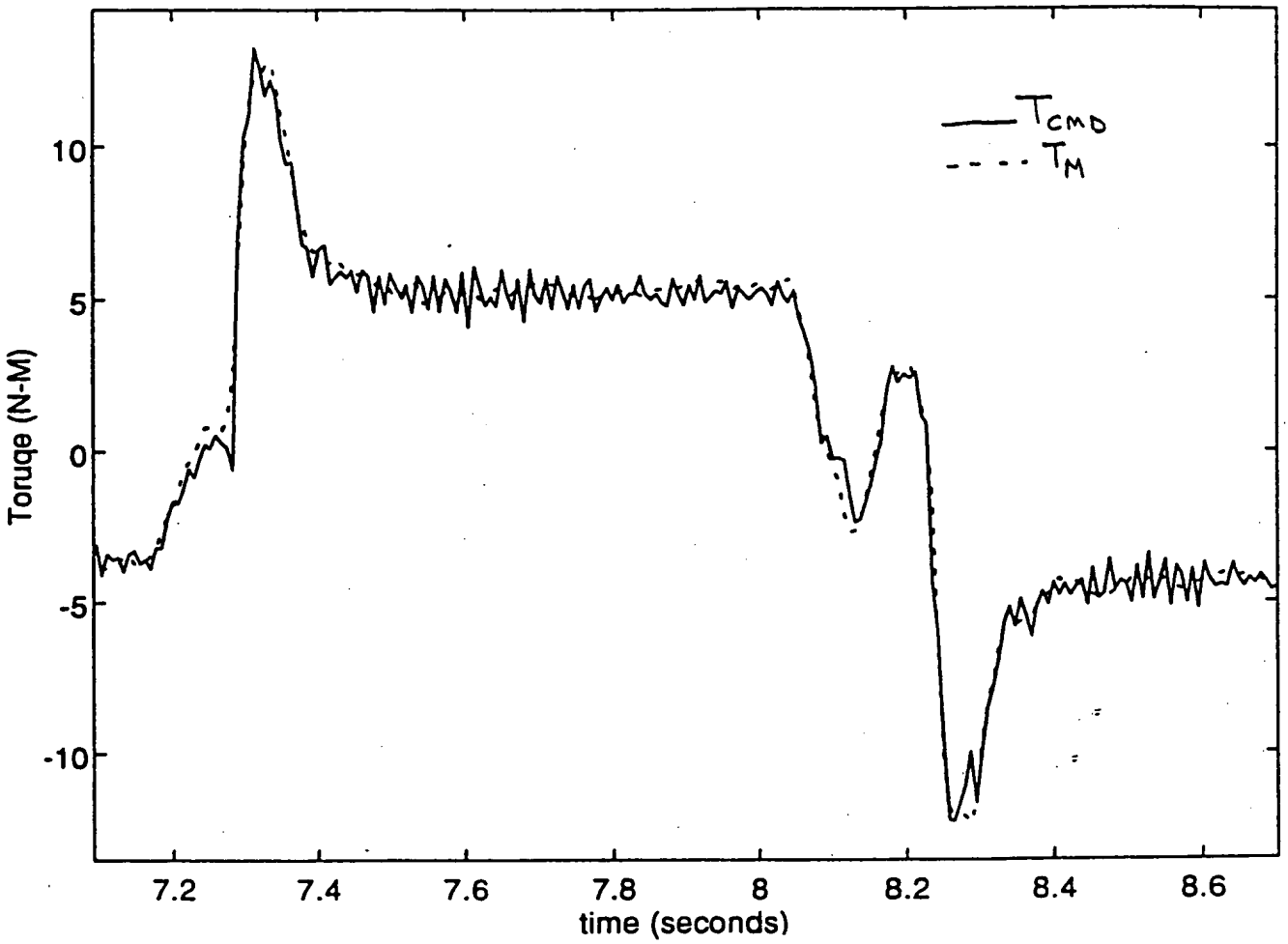


FIG. 11

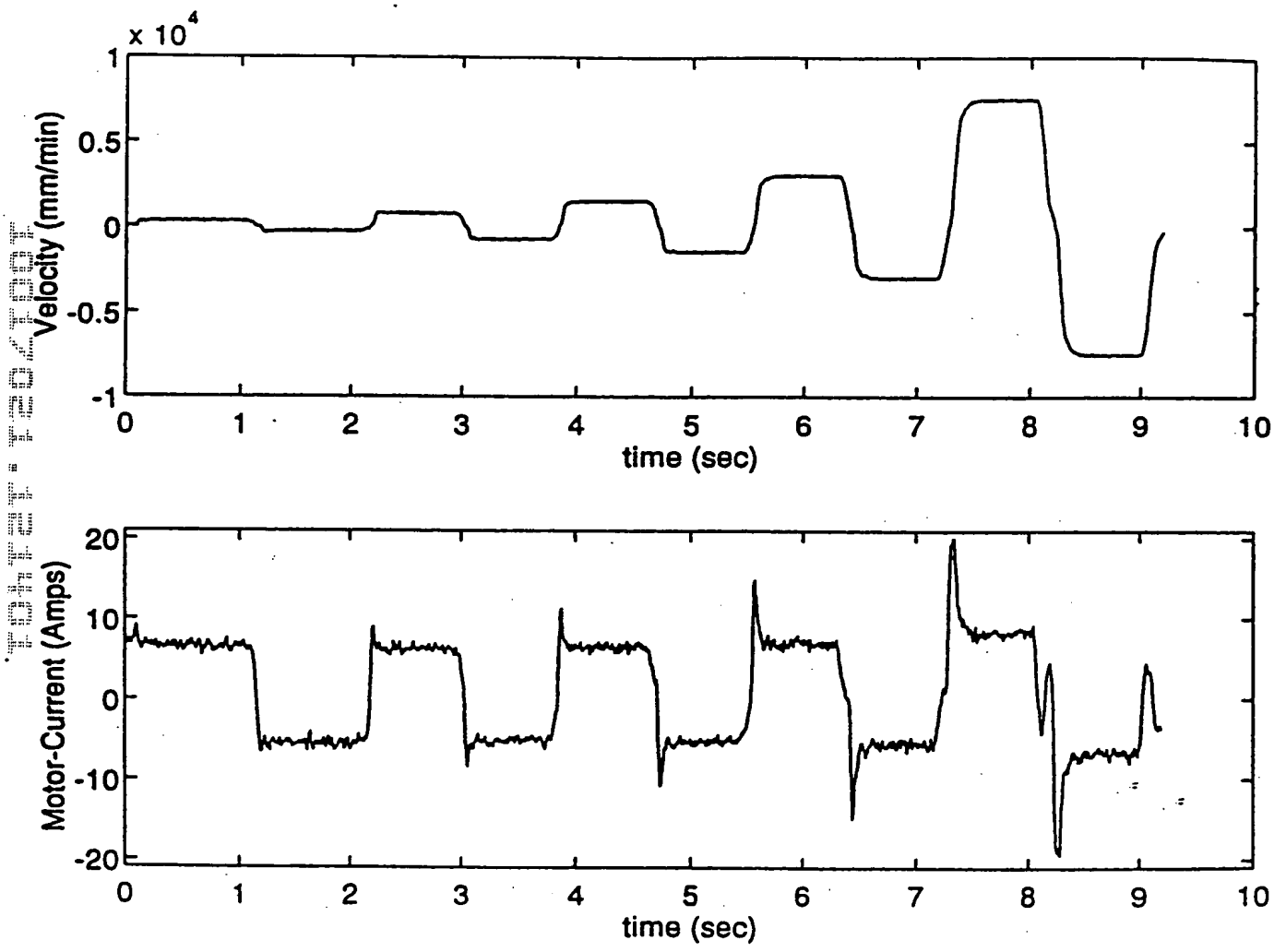


Fig. 12

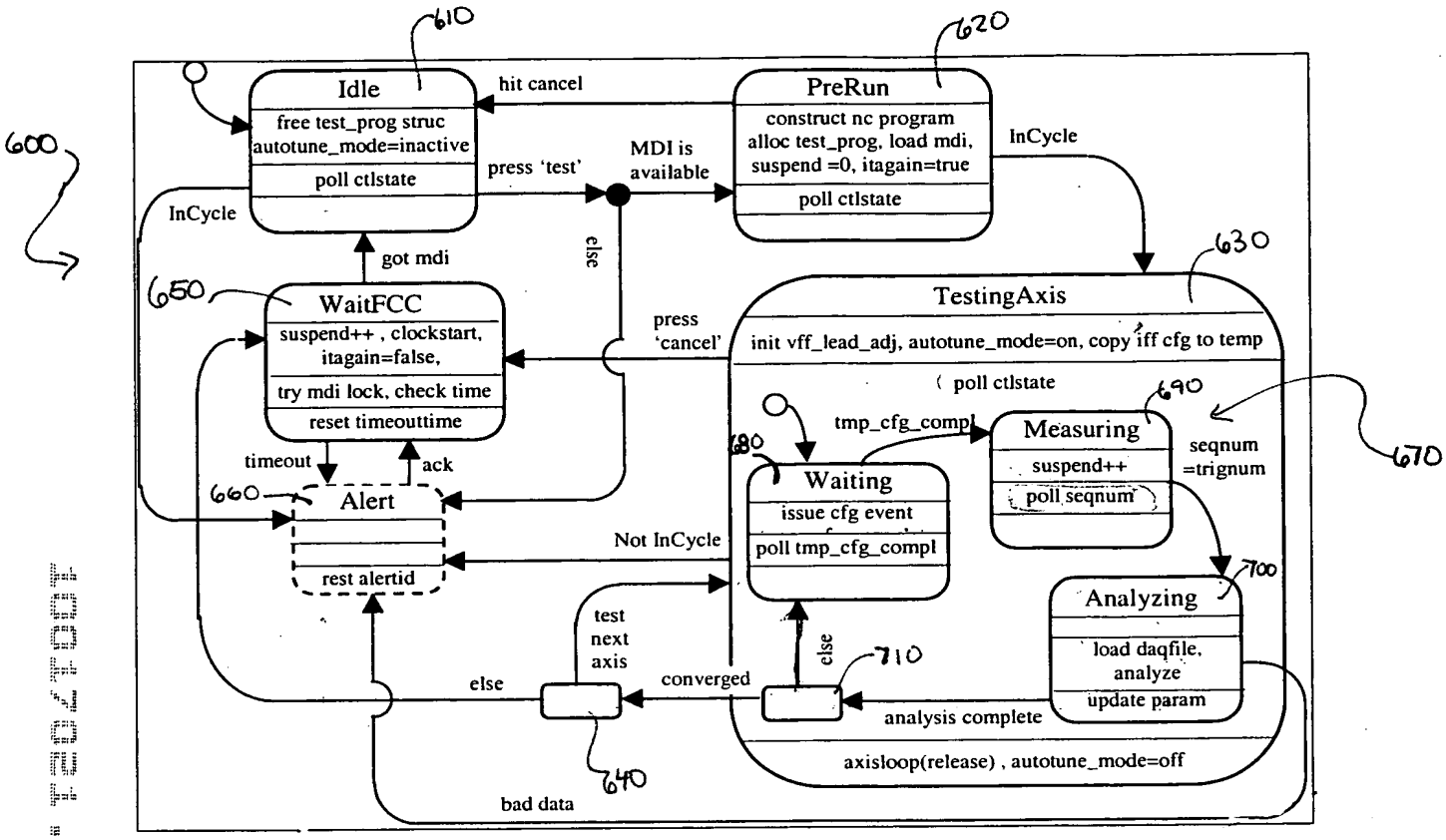

600
610
620
630
650
660
670
680
690
700
710
640
Idle
free test_prog struc
autotune_mode=inactive
poll ctlstate
hit cancel
PreRun
construct nc program
alloc test_prog, load mdi,
suspend =0, itagain=true
poll ctlstate
InCycle
press 'test'
MDI is
available
InCycle
got mdi
else
WaitFCC
suspend++ , clockstart,
itagain=false,
try mdi lock, check time
reset timeouttime
press
'cancel'
TestingAxis
init vff_lead_adj, autotune_mode=on, copy iff cfg to temp
(poll ctlstate
tmp_cfg_compl
Measuring
suspend++
poll seqnum
seqnum
=trignum
timeout
ack
Alert
rest alertid
Not InCycle
Waiting
issue cfg event
poll tmp_cfg_compl
Analyzing
load daqfile,
analyze
update param
test
next
axis
else
converged
else
analysis complete
axisloop(release) , autotune_mode=off
bad data

FIG. 14

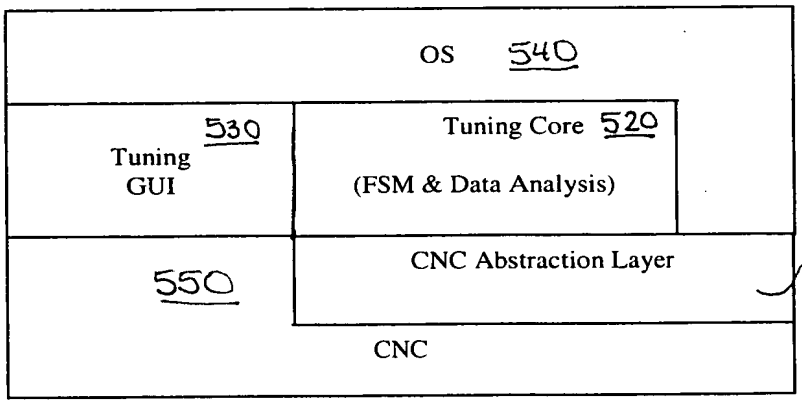

OS 540
Tuning
GUI
530
Tuning Core 520
(FSM & Data Analysis)
550
CNC Abstraction Layer
510
CNC

FIG. 13